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Ref: 8MO

August 15, 2002

MEMORANDUM

SUBJECT: Responses by Region 8 to National Remedy Review Board Recommendations for the Clark Fork River Superfund Site

FROM: John F. Wardell, Director, Montana Office

TO: Bruce K. Means, Chairman
National Remedy Review Board
Office of Solid Waste and Emergency Response
Washington, D.C. 20460

Background

During May of 2001, the EPA's National Remedy Review Board convened for several days at Fairmont Hot Springs, Montana (which is located within the upper Clark Fork River basin) to review the preliminary Clark Fork River Operable Unit, Million Reservoir/Clark Fork River Superfund Site proposed cleanup plan. On July 5, 2001, Review Board Chairman Bruce Means transmitted to Max Dobson, Assistant Regional Administrator, Region 8, a memorandum with eight advisory recommendations. The purpose of this memorandum is to respond to the eight recommendations presented by the National Remedy Review Board, in accordance with EPA guidance regarding the National Remedy Review Board. This response summarizes how the recommendations have been, and will further be, dealt with in the decision documents for the Clark Fork River OU.

<u>First Recommendation</u>: As presented, one important goal of the remedy is to reduce the potential for release of copper and other contaminants within the tailings deposits to the Clark Fork River. The preferred remedy includes a combination of treatment and removal of the exposed and fringe area tailings as well as other actions to stabilize the stream banks in impacted areas via revegetation of those banks and near-bank areas. Based on the package, it is unclear which risks drive these various actions. For example, short term acute impacts to fish might be adequately addressed by remediating only the exposed tailings in the flood plain; however, depending on the remediation alternative selected, that same action may contribute to the goal of long-term flood

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plain stability. The board recommends that the decision documents contain a clear discussion of the risk reduction benefits and cleanup time frames associated with the remedial alternative actions.

* Response.

The Proposed Plan contains a description of unacceptable risks found at the CFR OU at pages 5 through 7 and pages 7 through 11. The unacceptable risks extend beyond the acute risk from exposed tailings highlighted by the Board in its recommendation, and are based on detailed human health and environmental risk assessments prepared for the CFROU. To better clarify this point and to address the Board's recommendations, the following information is provided.

The proposed plan contains text at pages 13 through 16 addressing risk reduction benefits expected from each alternative. Additionally, the Feasibility Study was further developed, subsequent to the Review Board recommendations, to address more completely the issue of time frames for cleanup and risk reduction benefits expected for each alternative. Finally, the Preferred Remedy description in the Proposed Plan at pages 20 through 23 further link preferred remedy components with risk reduction benefits and specific unacceptable risks found at the CFR OU. A discussion of time frames specific to the Preferred Remedy is presented at page 26 of the Proposed Plan. Further explanation of EPA Region 8's analysis of this issue, with an emphasis on the benefits of remedial component integration to address the various unacceptable risks, is presented below.

Currently, environmental risks are most significant for riparian vegetation communities (including livestock forage and crops) and soil organisms at slickens and impacted soils and vegetation (or fringe) areas. When slickens or fringe areas are found along the banks of the river, this substantial terrestrial risk results in excessive erosion of lands along the Clark Fork River, especially in the upper reaches. Aquatic receptors, including algae and leafy water plants, invertebrate communities, and fish face the potential of significant risks resulting from thunderstorm runoff from slickens (pulses of dissolved metals). Low level, but still unacceptable, chronic risk to aquatic receptors exists from excessive bank erosion and copper and other metals contribution to the river, especially during high flow events.

The preferred remedy will interrupt the pathways that lead to unacceptable levels of environmental risk to terrestrial and aquatic receptors by removing and or treating slickens and impacted soils and vegetation areas; and by revegetating impacted streambanks. Many site specific factors influence the types of vegetation best suited for the flood plain and these will be further developed in consultation with individual land owners during remedial design.

Contribution to overall flood plain stability

The contribution made by implementing the preferred remedy toward reducing the threat of massive flood plain destabilization, or unraveling, is much more complicated and uncertain.

Should a large flood cause the flood plain to unravel, both the ecology and geomorphology of the flood plain and stream would certainly be altered catastrophically. However, the river's susceptibility to such an event, as well as the flow and flood duration required to cause the flood plain to unravel, are highly uncertain.

Thus, the preferred remedy focuses on reducing terrestrial and aquatic environmental risks of the usual type. Reducing the risk of unraveling remains a goal; however, the contribution made by the preferred remedy toward achieving that goal will remain uncertain. Region 8 believes that the preferred remedial action for stabilizing stream banks against excessive erosion and channel migration will also contribute significantly to reducing the threat of unraveling.

Reducing risks at slickens (exposed tailings deposits generally void of vegetation)

Remedial actions designed to revegetate slickens, whether by in situ treatment or by removal and replacement, will effectively interrupt the potential for pulses of dissolved metals runoff during late summer thunderstorms.

Slickens that present the greatest threat for aquatic harm are those located on or very near the active channel (contiguous with, or within approximately 25 feet of the channel). Remedial actions for near-channel slickens must include efforts to not only interrupt the potential for late summer pulse-type runoff of dissolved metals into the stream, but to also stabilize banks in order to reduce erosion and retard the rate of channel migration. Following removal of these phytotoxic soils, bank reconstruction and revegetation will occur.

Slickens located more than about 25 feet from the active channel present both a lesser threat of pulses to the stream and a lesser threat of exacerbating bank erosion. However, these will also undergo remediation in accordance with the Proposed Plan criteria for removal or in situ treatment of these slickens areas. Although slickens farther removed from the active channel may present conditions that increase the threat of flood plain unraveling (in the event of a very large flood), these areas also possess the potential for becoming important hay pastures for ranchers who own the land on the flood plain. Thus, revegetation efforts–particularly away from the active stream channel–should be consistent with the landowner's needs. Improvements in hay production or forage in these areas will be necessary in order to offset the loss of hay production and forage associated with the preferred remedy for the near-channel corridor.

Reducing risks at fringe areas

Fringe areas are characterized by reduced plant species richness and less than adequate ground cover. These are manifestations of impacted soil conditions, although the soils of fringe areas are generally less acidic and higher in organic content than soils of slickens.

Although vegetation in fringe areas may currently be sufficient to prevent pulses of dissolved metals runoff into the stream, the ecological functional health of plant communities and soil organisms in fringe areas is deficient and present unacceptable risk to the terrestrial environments at the site. Thus, hay production and forage are generally poor to very poor in fringe areas, as is plant growth for lowlands and aquatic wildlife. Risks to some species of wildlife are predicted to be low to moderate - there is uncertainty associated with this finding but the actions in addressing fringe areas may be a cost effective way to address these risks. Where fringe areas have been intercepted by the migrating channel, poorly vegetated banks cannot withstand the forces of erosion. Although the soils are usually not phytotoxic, erosive forces overcome the bank before willows have a chance to mature and hold the bank together. This condition is rather common along the river, and it is this condition for which the EPA's stream bank stabilization component was primarily developed. Approximately 55 miles of banks in Reach A (of about 86 miles total, factoring in both the left and right banks of the active channel) will require remedial action in order to reduce erosion and channel migration to acceptable rates.

Integrated approach to environmental risk reduction

Risk reduction, therefore, should be visualized as an integrated set of remedial actions; each dependent upon the success of the other members of the set. For example, although bank stabilization is a necessary remedial component, and will reduce sedimentation, copper loading and excessive channel migration, bank stabilization by itself will not measurably reduce any low chronic stress to aquatic receptors that may persist. Bank stabilization by itself will not end the threat of pulses, but it will provide significant ancillary benefits to the aquatic community by improving habitat. Moreover, bank stabilization will bring water quality to a level where exceedences of state standards will occur less often than in the absence of such an action.

As a final note regarding risk reduction, human risks are limited by the absence of residences within the flood plain and by the relatively low level of contact by ranch workers and recreationists with arsenic-contaminated soils in the flood plain. A time-critical removal action was conducted where formerly irrigated lands became residential yards. It is expected that risk reduction through implementation of remedial actions at this operable unit will be primarily focused on environmental receptors, although additional monitoring for potential human health risks and institutional control implementation may be conducted in selected areas. Specific human health components of EPA's Preferred Remedy are described at page 22 through 23 of the Proposed Plan.

Time frames

EPA estimates that the stream bank stabilization component of the remedy will require five to seven years of construction, followed by long-term O&M and permanent best management practices. Once the banks are well vegetated, water quality will improve, instream sediments will be markedly reduced and the threat of unraveling will be lessened. But, maturation of a continuous riparian corridor is likely to require at least 10 to 20 years of careful management.

Remedial action construction for slickens and fringe areas may require a longer period than construction of bank stabilization actions. As removal of contaminated materials at slickens and fringe areas increases, the time required for implementation increases.

The two alternative cleanup strategies (removal and replacement or in situ treatment) may be effective, although neither strategy has been monitored for more than about a decade. The preferred remedy will attempt to fairly balance removal and in-situ treatment to emphasize effectiveness and permanence.

(References: National Remedy Review Board Presentation Package, April 2001. Clark Fork River Ecological Risk Assessment, Final Report, October 2001. Clark Fork Operable Unit Feasibility Study Report, Public Review Draft, March 2002. Riparian Assessment of Two Upper Clark Fork Basin Locations, March 2002.)

Second recommendation. The Board noted that a set of two formulas developed in the ecological risk assessment and a "riparian evaluation system" will be used to identify areas requiring remedial action. While the Board supports the use of such a decision tree in concept, it is unclear how the formulas and evaluation system, when coupled together, relate to ecological risk-based determinations of unacceptable terrestrial risk or appropriate measures for determining acceptable levels of residual risk. The board recommends that these matters be clarified in the site decision documents.

*Response.

These two formulas were developed from site-specific soils and riparian vegetation data. The measurement endpoints of biomass and species richness can be quantitatively characterized by application of a bivariate model that is based on total metals content of the soil and soil pH. Using the 5th percentile of biomass and species richness at control sites (riparian polygons unimpacted by mining wastes), a boundary between "effect" and "no effect" was developed for upper Clark Fork River plant communities.

The Riparian Evaluation System (RipES) was jointly developed by the Reclamation Research Unit at Montana State University and the Riparian and Wetland Research Team at the University of Montana (Draft Report, December 2000). It embodies a numerical scoring system that assesses terrestrial risk by evaluating three ecosystem components: plant community integrity, contamination severity, and landscape stability. Within the contamination severity component, each of the following parameters is given a numerical value: volume and concentration of metals, geochemical mobility of the metals, contamination-caused bare ground, and proximity of contaminated materials to the stream bank. The proposed plan on page 22 indicates the RipES methodology will be further developed and used to more clearly identify areas for action, and what type of action, in accordance with criteria for use of removal or in situ treatment selected in a Record of Decision (criteria are proposed in the Proposed Plan - see Response to Recommendation number 4 below).

As discussed above, the ecological risk assessment formulas define phytotoxicity (reduced biomass or species richness, or both) as a function of soil metals concentrations and soil pH. The formulas may be directly used in the Riparian Evaluation System when location-specific soil metals and pH data are known. These concepts are addressed in some detail in the RipES document and have been integrated into the RipES scoring system. In addition, lists of tolerant and sensitive plant species are used to help assess evidence of phytotoxic conditions arising from mining wastes–principally conditions of low soil pH. Field application of the Riparian Evaluation System supports the general conclusion that reduced biomass and reduced plant species richness "appear to be determined more by the soil pH (less than about [pH] 5.5) than by the level of metal contamination." Further field truthing of the RipES methodology will be done to further refine its ability to identify areas that require remedial action and those that do not.

Assessing acceptable levels of residual risk (leaving contamination on the flood plain) can be derived by using threshold values established by the Riparian Evaluation System. These threshold values, coupled with remedial action selection criteria and modifying factors, will be used to separate locations requiring remedial action from locations requiring no additional action (other than continued or improved best management practices).

(References: Clark Fork River Ecological Risk Assessment Final Report, October 2001. Riparian Evaluation System Draft Document, authored by RRU-MSU and RWRP-UM, December 2000.)

<u>Third recommendation</u>. The Board noted that in situ treatment at the Governor's Demonstration Project has been in place for about a decade, and that in situ treatment is substantially less costly and requires less time for implementation than removal and replacement. But, the Board received differing views from stakeholders regarding the long-term effectiveness of in situ treatment. The Board recommended a more thorough review of available data to ensure that the buffering capacity will not be lost due to infiltration and runoff at a rate that would hinder long-term performance of the treatment. The Board recommended that effectiveness information should be made more readily available to the public and that the bases for projected long-term performance should be clearly described in decision documents.

*Response.

In response to this recommendation, the Montana Office of EPA convened a two-day scientific panel review to consider the issues. A panel of 10 scientists researched and reviewed all available data regarding in situ treatment and considered the elements of the Board's questions and recommendations. Two Remedy Review Board members, Patricia Erickson and

Ron Wilhelm, participated in part of the review by phone. They were particularly instrumental in the formulation of questions for the review panel's consideration.

The longevity of the buffering capacity in the treated soils and mining wastes was assessed during the panel review and is discussed in greater detail in the follow-up document. Three factors that can deplete lime that is added to the soils and mining wastes were thoroughly evaluated: acid rain, overland flooding and precipitation and leaching of the soil profile. Conclusions drawn are summarized as follows:

1. Acid rain will not impact the permanence of in situ treatment of acid systems, as it is estimated that it would take 1,130 years of acid rain to deplete one ton of lime per acre.

2. Overland flooding. If runoff water remains within the USGS-measured pH range of about 8.3 to 9.3 for the upper river, the water is expected to be saturated with calcium carbonate. Thus, leaching of applied lime, from amended soils, is not likely to occur during overland flooding. Overland flooding occurs approximately every second or third year, and its duration rarely exceeds 10 to 15 days.

3. Precipitation and leaching of the soil profile. Model predictions estimated that one ton of lime could be leached from the 0-6 inch soil depth in 7 years in coarse-textured soils and in 83 years in fine-textured soils. It was concluded that leaching is not negligible, and may impact long term performance; however, it was further concluded that additional lime can be included to effectively account for long-term leaching. Calculations of the amount of lime to add to acidic soils and tailings is based on the (a) active acidity within the material, (b) the potential for the material to produce acid in the future through oxidation of some remaining pyrite minerals, and (c) any innate neutralizing capacity of the material.

EPA has received comments that a shortcoming of the lime equation is that it does not consider the relative rates of dissolution of the acid producing and acid neutralizing minerals over time. The comment added that the best way to determine more accurate lime rates is to use long-term kinetics tests (humidity cell tests) on a large number of samples and on an ongoing basis.

The lime rate equation has been evaluated at numerous field sites in Montana for many years and site acidification has not occurred as a result of rapid dissolution of acid-producing minerals, compared to neutralizing minerals. These field demonstration results are notably more valuable and reliable compared to those derived from laboratory kinetics tests.

In the proposed plan, EPA attempted to identify the best combination of removal and in situ treatment in order to match its technical evaluation of in situ treatment that occurred as part of the RI/FS process and subsequent evaluation. That technical evaluation demonstrated general reliability, with appropriate and careful implementation and operation and maintenance, for in situ treatment while identifying uncertainties for implementation in deeper and wetter areas, and in areas of low pH tailings (low pH tailings areas which are exposed are the principle threat waste at the site). The proposed plan generally calls for removal of wastes in these situations. In other less impacted areas, EPA believes the carefully calculated lime rate incorporated thoroughly will permanently neutralize acid-producing soils and tailings along the Clark Fork River.

(References: Responses to Issues Posed by the EPA National Remedy Review Board Regarding Phytostabilization of the Clark Fork River Operable Unit, Million Sediments Superfund Site, December 2001. Review comments by Ann Maest, for Montana Natural Resources Damage Program, April 11, 2002. Memorandum of July 11, 2002, by CH2M Hill, in response to review comments by Maest.)

<u>Fourth recommendation</u>. The Board noted that stream bank erosion accounts for 60% of copper loading to the Clark Fork River, and that stabilization of eroding banks is an important component of the preferred remedy. The Board recommended a clearer description of how the stream bank stabilization component was selected, and to provide a clearer supporting rationale for the benefits of stabilizing 298,848 feet of bank, relative to other alternatives that would stabilize less.

*Response.

The contribution of copper from bank erosion (60% of all sources) is derived directly from USGS-measured sediment loading data. The figure pertains to the upper reach of the river only (Reach A). Mean annual copper load leaving Reach A over the past 10 years was 16.6 tons (10 tons originated from erosion of banks in Reach A and 5 tons originated from tributaries and upstream sources). In 1997, the last year of a moderate over bank spring flood, 39.1 tons of copper flowed out of Reach A, while 12 tons entered Reach A from tributaries and upstream sources. Reaches B and C generate more copper loading than Reach A; they added 54 tons to the system in 1997. However, these reaches have the benefit of substantially increased flows from tributary sources which offset this loading.

The stream bank stabilization component of the preferred remedy was developed by EPA and its technical advisers, including USGS hydrologists, during the feasibility study. It was developed in response to the inadequacies of stream bank stabilization alternatives being developed for Reach A by the author of the feasibility study, the Atlantic Richfield Company (PRP). Not until EPA developed its alternative for stream banks was there an action directed at reducing channel migration rates over the entire 43-mile reach, and in a manner consistent with the ecology and geomorphology of this low-bank, single-thread meandering stream.

A principal objective of the alternative developed by EPA is to reduce excessive bank erosion and accelerated channel migration by replicating nature's efforts at restoring the stream and flood plain. Nature's way is to line the banks and near-channel corridor with willows or other large shrubs that have deep, bank-binding roots and a thick, overlapping canopy overhead. Nature's efforts to reconstruct such a condition along the upper Clark Fork River are evident at many locations; however, the forces of erosion, which often overcome the ability of young willows to mature, and overuse by livestock sometimes thwart those efforts. Because approximately 55 miles of banks within Reach A (factoring in both the right and left banks, there are approximately 86 miles of banks between Warm Springs and Garrison) lack sufficient "woody" vegetation to maintain bank stability, the newly-developed alternative applies the following rationale: If only the worst eroding banks (currently eroding at a rate of between 2.5 and 5.8 feet per year) are stabilized, other unvegetated banks (currently eroding less than about 2.5 feet per year) will immediately begin to erode at the greater rate.

Further, it must be understood that the worst eroding banks are not always the most contaminated banks. The most contaminated banks, by virtue of their being too acidic to support mature willow transplants, constitute a small percentage of eroding banks (perhaps fewer than 5% of the banks). These banks will require precision-type removal and reconstruction prior to revegetation efforts. Virtually all other banks, eroding or not, are comprised of lenses of tailings, mixed soils and tailings, historic flood plain soils (buried A horizon), and bank toe gravels and cobbles. All of these layers, except the toe gravels and cobbles, are enriched with metals. Therefore, because the sources of sediments and copper to the stream are ubiquitous, any effort to reduce inputs of sediments and copper will be ineffective, overall, unless all unvegetated banks become lined with woody vegetation.

The rationale for a corridor that is approximately 50 feet wide, on both sides of the stream, arises from the recognition that a naturally meandering stream will continue to migrate back and forth across the flood plain, albeit at a much reduced pace. Thus, as high spring floods occur (every few years, or more frequently), it is natural to lose near-channel willows and see the channel move. (USGS estimates that a more natural rate of bank retreat for this river would average about 0.10 to 0.25 feet per year.) Multiple rows of willows, or "additional lines of defense" will prevent the banks from becoming completely open to erosion once again. Multiple rows and a thick canopy above the flood plain surface will also offer some protection against rapid flood plain destabilization, or unraveling, in the event of abnormally high and sustained runoff.

(References: Various reports prepared by the Clark Fork River Geomorphology Study Committee, including the USGS summary report, Geomorphology, Flood-Plain Tailings, and Metal Transport in the Upper Clark Fork Valley, Montana, October 1998. Clark Fork River Operable Unit Feasibility Study Report, Public Review Draft, March 2002.)

<u>Fifth recommendation</u>. The Board noted that the remedy relies heavily on establishing and maintaining healthy riparian vegetation, over the long term, in order to prevent excessive erosion and prevent flood plain destabilization. Given the extensive cattle grazing that occurs, however,

the Board recommended that the decision documents should address the issue by describing the types and feasibility of management approaches necessary to ensure the long-term reliability of stabilization efforts.

*Response.

The need for grazing management and other best management practices in the riparian corridor is a very important part of any reclamation effort, no matter what cleanup action occurs. The proposed plan recognizes this by discussing the role of institutional controls and best management practices on pages 23 through 26. That discussion is based upon the following considerations

During construction, which may require longer periods for removal strategies and shorter periods for in situ strategies, cattle grazing within the 50-foot near-channel corridor will likely have to be curtailed. The length of time for these restrictions will depend on the degree of ecological dysfunction present at the beginning of construction, the amount of disruption and time needed to construct the remedy, and the recovery response by vegetation. Those factors vary significantly from location to location. The goal would be to complete construction within two years on any landowner's property and to allow as much of the historical use as possible while still maintaining the effectiveness of cleanup.

Grazing restrictions should not be kept in place any longer than is necessary. As rapidly as possible, after construction and a period of maturation for the vegetation, cattle use should be allowed, but carefully managed. Cooperation throughout the process, among ranch owners, the Atlantic Richfield Company (PRP), U.S. Department of Agriculture, the Deer Lodge Valley Conservation District Board, Montana Extension Service, and other entities, including EPA and MDEQ, will be essential to ensure the long term reliability of the bank stabilization efforts and success of the riparian corridor.

The Montana State University Extension Service has developed a complete guide to stream and riparian management that is accessible to ranchers and managers through an online study course (http://www.homepage.montana.edu/~stream/). This course is currently being used by managers, ranchers, and producers in several western states and Canada. Riparian management plans will be developed for each rancher as operation-specific objectives and resources are taken into consideration. As stated in the proposed plan, the PRP would be expected to fund this effort. General principles for managing grazing livestock in riparian areas include the following (some of which are also highlighted in a separate box in the proposed plan):

- Taylor grazing approach to specific riparian areas;
- Incorporate riparian management into overall ranch management;
- Select season(s) of use for grazing compatible with livestock behavior, riparian conditions, and management objectives;
- Limit livestock use in sensitive riparian areas;

- Distribute livestock within targeted pastures;
- Ensure adequate residual vegetative cover, and provide adequate regrowth time and rest for plants; and
- Actively manage (operators' responsibility) to maintain and enhance riparian health.

Development and maintenance of best management practices and other institutional controls will ensure the long-term reliability of stabilization efforts. Monitoring of these areas and assessments of whether remedial objectives are being met will be part of an overall O&M plan to be developed in remedial design. Additionally, reviews will be done at 5 year intervals to evaluate the success or failure of the remedy and ensure that corrections will be made as needed.

(References: Suber and Ehrhart, 1998. Best Management Practices for Grazing, Montana Department of Natural Resources and Conservation, 1999. Livestock Grazing on Western Riparian Areas, U.S. EPA, July 1990 and July 1993 (update). Prescribed Grazing Practices for Water Quality Protection on Montana's Grazing Lands, Montana State University, August 2000. Personal interviews with USDA range scientists and Conservation District Board members, Deer Lodge.)

<u>Sixth recommendation</u>. It is unclear to the Board how the preferred remedy would attain protectiveness for ground water over the entire operable unit and for surface water drinking standards for arsenic in Reaches B and C. A recommendation was made to address these concerns in the decision documents.

*Response.

Ground water protectiveness in the short term will be provided through the use of institutional controls (some of which already exist) to prevent domestic use of the shallow ground water found at the operable unit. EPA Region 8 believes that the combination of removal and in-situ treatment found in the Proposed Plan will ultimately lead to compliance with ground water ARARs at areas outside of waste management units, in accordance with the NCP through removal of some of the worst and most mobile of the contamination (most slickens and saturated fringe areas) and increased plant growth and water use in other remediated areas. - and this will lead to long term protectiveness. EPA Region 8 recognizes the uncertainty associated with this element and will require monitoring of the CFR OU.

Surface water and compliance with arsenic standards (10 ppb dissolved) presents difficult issues at this OU. Arsenic is ubiquitous in the area and in tributaries, and compliance with the standard is therefore very difficult. The river is designated as a drinking water source, but there are no documented long term uses of direct river water as a drinking water source. The Proposed Plan recognizes the uncertainty associated with meeting surface water ARARs with the preferred remedy or any other remedy at page 16 of the Proposed Plan, and a waiver of the surface water standard may be appropriate in the Record of Decision or the post record of decision time frame, at least for certain events. Monitoring data and further examination of recent modelling efforts will help EPA further examine this issue. Additional explanation of EPA's response to the Board's recommendation on this topic is presented below.

Adsorption of copper and arsenic to clay particles and organic matter (both clay and organic matter are present in the buried A horizon soils) are key mechanisms for contaminant attenuation in the vadose zone. Thus, in areas where buried soils are thin or absent, pore water moving downward or laterally or upward contributes copper and arsenic (and other contaminants) to the shallow ground water more than where buried soils are relatively thick and continuous. Areas of thin or absent buried soils are highly variable; such that along any subreach, on either side of the active channel, pore water continues to transport copper and arsenic to the shallow ground water. The sources and pathways are diffuse and ubiquitous. Low pH conditions exacerbate mobilization of copper, and, depending upon its oxidation state, arsenic as well.

With respect to arsenic movement and loading of arsenic in ground water and surface water, separate studies by EPA and the Atlantic Richfield Company (PRP) indicate that shallow ground water monitoring wells often exceed the standard of 10 micrograms per liter. These wells are not used for drinking water. Domestic wells near the river are generally much deeper than the extent to which arsenic has moved downward.

Arsenic loading in surface water increases through all three reaches. Total recoverable arsenic entering Reach A from upstream averages 2.7 tons per year and increases to 6.0 tons at Deer Lodge and to 12.1 tons at Turah. Through the Deer Lodge valley (Reach A), about 3.5 tons per year are generated from bank erosion and groundwater. There is some interaction between surface water and the bed and point bars. In the upper river, above Deer Lodge, about 90% of total recoverable arsenic is in the dissolved form.

Under current conditions, average annual concentrations of total recoverable arsenic in surface water range from 26 micrograms per liter near Galen, to 23 micrograms per liter at Deer Lodge, to 9 micrograms per liter near Turah. Implementation of combinations of Alternatives 4 and 5, with EPA's bank stabilization subalternative, is predicted to result in a decrease in the average annual total recoverable arsenic at Deer Lodge, to 16 micrograms per liter. But, it is predicted there would be no change in arsenic concentrations at Turah (still 9 micrograms per liter). These are average concentrations. Protectiveness and the human health ARAR standard for arsenic are measured as dissolved standards however. The relationship of these predictions to a dissolved standard will be further examined and discussed in the Record of Decision or the post decision documents.

(References: Clark Fork River Operable Unit Feasibility Study Report, Public Review Draft, March 2002. USGS Water Quality Data Reports, 1991-2001. Responses to Issues Posed by the

EPA National Remedy Review Board Regarding Phytostabilization of the Clark Fork River Operable Unit, Million Sediments Superfund Site, December 2001. Determination of Total Recoverable and Dissolved Arsenic Loads, Upper Clark Fork River, March 2002.)

Seventh recommendation. The Board noted that in other regions of the country, "more conventional" remedial strategies are not screened out early in an alternatives analysis. The Board recommended that the decision documents should include a clear discussion of why capping of slickens and "hard" methods for bank stabilization were not carried through a detailed analysis.

*Response.

Although capping of slickens and "hard" methods for stream bank stabilization were not carried through the detailed analysis, both remedial strategies were carefully considered before being screened out.

Capping

Slickens, and other, similar deposits of acid-generating, fine-textured tailings, have been capped in demonstration projects within the Clark Fork basin. For example, the Anaconda Tailings Ponds near the headwaters of this operable unit have been capped, in both demonstrations and components of the selected remedial action. Beneath such caps, however, a layer of limestone is necessary to prevent upward movement (capillary action) of dissolved metals. Capping along the active flood plain of the Clark Fork River presents several problems.

a. The limestone layer needed to prevent upward movement of water and dissolved metals would preclude willows and other deep-rooting vegetation. As discussed above, woody vegetation is vital to stabilizing the banks and near-channel areas. Also, a vital agricultural plant, alfalfa, which roots as deep as 6 feet or more, would be precluded.

b. The integrity of a layer of limestone over a layer of imported soil, or a cap, will surely fail in a moderate to high spring runoff. (This flood plain, as with any similar flood plain, becomes mixed and blended in every over bank flow. The remedy is designed to allow channel migration at a much-reduced rate, but capped areas would, nonetheless, eventually be eroded into the stream, with the tailings unamended.

c. A cap and limestone over tailings would preclude land use changes by ranchers and farmers. The principal land use here is agriculture. Ranchers commonly change their practices and rotate crops grown on riparian pastures. No tilling would be possible.

Capping was evaluated early in the feasibility study process. For the reasons discussed above, and for the reason that capping is known to be more costly and less effective than in situ treatment, it was not carried into the detailed analysis.

Hard engineering for banks

Extensive use of rip rap and its associated channelization were discussed early in the feasibility study by a representative group of stakeholders. Every participant–from environmentalist to landowner to local government official–rejected converting the upper reach (Reach A) into a stream resembling either of the two lower reaches (Reach A or B). Due to extensive hard engineering along the lower reaches, the river erodes excessively and in unpredictable fashion, sedimentation and stream braiding are high, and both terrestrial and aquatic habitat have been severely impacted. Unanimously, the decision was made early to keep rip rap and other hard, unnatural methods out of the analysis for the upper river. Both the ecology and geomorphic integrity of the flood plain would be altered by hard engineering.

<u>Eighth recommendation</u>. The Board noted that the cost estimates presented in Exhibit 31 include a category of miscellaneous costs that range as high as 25% to 30& of net present value. The Board recommended an evaluation of the appropriateness of these costs, and in future documents, cost breakdowns should be better explained.

*Response.

In the feasibility study report, Appendix H, Cost Estimates, the Atlantic Richfield Company presented three cost categories. The first was construction costs, which considered quantities of materials and their respective unit costs. The second was annual monitoring and maintenance costs. The third was miscellaneous costs, which included percentage of capital costs such as contractor mobilization and demobilization costs (5%), construction management fees (6%), design fees (6%), contractor profit (10%), project management fees (5%) and project contingencies (10%). These costs and their breakdown are deemed by Region 8 to be reasonable. They should have been footnoted as part of Exhibit 31.

(Reference: Clark Fork River Operable Unit Feasibility Study Report, public review draft, Atlantic Richfield Company, March 2002.)